

CLAIMS

1. Method for selective separation of each of the constituents of a mixture of synthetic organic materials that are polymers and/or copolymers, in particular used, and intended to be upgraded by recycling, having a density
5 of at least 1, in fragmented form, consisting of carrying out their separation by introducing said mixture into a dense liquid medium, which is an aqueous suspension of powder particles dispersed in an adequate amount in an aqueous phase, in order to create a density level "ds"
10 chosen as the threshold for separation of the various fragmented synthetic organic materials to be selectively separated by type, characterised in that said separating suspension is made selective, stable and invariant with regard to density at a precision level of ± 0.0005 with
15 respect to the density threshold "ds" chosen for the selective separation:

a) by the size selection of powder particles having a granulometric cross-section of no more than 30 μm , which solid powder particles thus sized are
20 dispersed and present in an aqueous phase in a sufficient amount to reach the chosen density threshold "ds", and

b) by the implementation of at least one means of dynamic stabilisation by creating a circulating flow of
25 said separating suspension, which circulating flow is at most 40 m^3/h .

2. Method according to claim 1, characterised in that said separating suspension is made selective, stable and
30 invariant with regard to density at a precision level of ± 0.0005 with respect to the density threshold "ds" chosen

for the selective separation, by the size selection of solid powder particles of which the granulometric cross-section is preferably no more than 20 μm , and very preferably no more than 5 μm , which solid powder particles
5 thus sized are dispersed and present in an aqueous phase in a sufficient amount to reach the chosen density threshold "ds".

3. Method according to claim 1, characterised in that the
10 powder particles are of natural origin and are chosen from the group of powder mineral materials constituted by clays belonging to the families formed by the group of kaolinites, including, kaolinite, dickite, halloysite, disordered kaolinites, serpentines, the group of micas, in
15 particular, muscovite, biotite and paragonite, pyrophyllite and talc, illites and glauconite, the group of montmorillonites, in particular beidellite, stevensite, saponite and hectorite; the group of chlorites; the group of vermiculites; the group of interstratified clays of
20 which the unitary structure is a combination of the previous groups; the group of fibrous clays, in particular attapulgite (palygorskite) and sepiolite; the group formed by calcium carbonate (calcite), magnesium carbonate, dolomite (double carbonate of calcium and magnesium),
25 calcium sulphate dihydrate (gypsum), barium sulphate, talc, alumina, silica, titanium dioxide and zirconium.

4. Method according to claim 1, characterised in that the
powder particles are of synthetic origin and are chosen
30 from the group consisting of glass powders, calcium carbonate precipitate and metallic powders.

5. Method according to at least one of claims 1 to 4, characterised in that the powder particles have a median diameter of no more than 5 μm and preferably between 1 μm and 0.005 μm .

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6. Method according to at least one of claims 1 to 5, characterised in that the means of dynamic stabilization are selected from the group consisting of agitation by means of an agitation rotor, internal recirculation of the suspension by means of the agitation rotor, external recirculation of the suspension by means of a pump by withdrawing the suspension from the base of the container where it is located and by reinjection into the upper portion of said container, or by a combination of means enabling both the agitation by means of an agitation rotor and the internal and/or external recirculation of the suspension.

7. Method according to at least one of claims 1 to 6, characterised in that the means of dynamic stabilisation consist of continuous or non-continuous recirculation of the suspension.

8. Method according to claim 1, characterised in that the circulating flow of the separating suspension is between 5 and 30 m^3/h and preferably between 5 and 15 m^3/h .

9. Method according to at least one of claims 1 to 8, characterised in that the circulating flow of the separating suspension is adjusted at an hourly turnover rate of said suspension between 0.5 and 4 and preferably between 0.5 and 2.

10. Method according to at least one of claims 1 to 9, characterised in that the aqueous phase has a conductivity of no more than 50 ms and preferably between 0.2 ms and 40 ms.

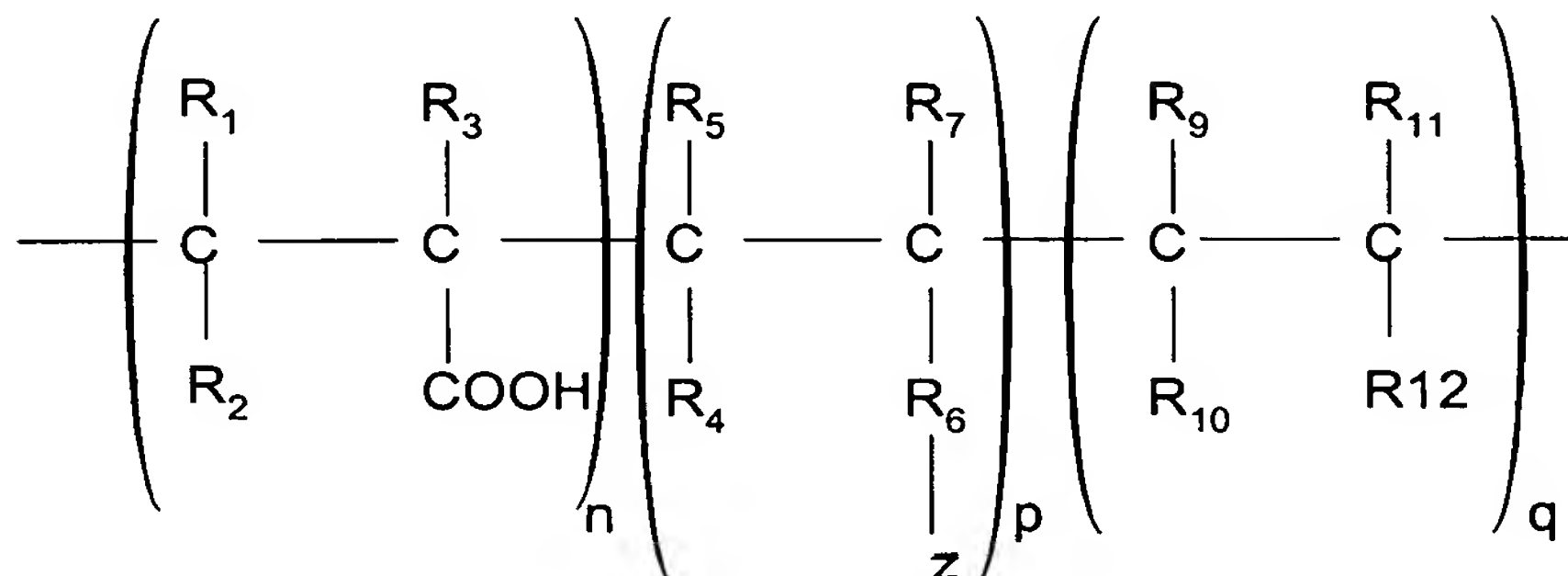
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11. Method according to at least one of claims 1 to 10, characterised in that a water-soluble agent for assisting with the stabilization of the rheological and invariance characteristics of the apparent density "ds" of the solid
10 powder particle suspension is added to said suspension.

12. Method according to claim 11, characterised in that the water-soluble agent for assisting with the stabilization of the rheological and invariance
15 characteristics of the apparent density "ds" of the solid powder particle suspension is chosen from the group consisting of phosphates and polyphosphates, alkylphosphate esters, alkylphosphonate, alkylsulphate, alkylsulfonate, lignin, lignosulfonates in the form of
20 calcium, sodium, iron, chromium, or iron and chromium salts, maleic anhydride and sulfonic styrene acid copolymers, substituted, neutralised, esterified or non-esterified methylacrylamide and (methyl)acrylic acid copolymers, methylacrylamide-alkyl sulfonic acid and
25 (methyl)acrylamide copolymers, water-soluble acrylic acid polymers used in acid form or, optionally, entirely or partially neutralised by alkaline and/or alkaline-earth agents, by amines and/or salified by monovalent and/or polyvalent ions, and/or esterified, or from water-soluble
30 acrylic copolymers having phosphatized, phosphonated, sulfated or sulfonated functions.

13. Method according to either one of claims 11 and 12, characterised in that the water-soluble stabilisation

agent is preferably selected from the water-soluble acrylic copolymers, having the general formula:



5 wherein

- Z is a phosphate, phosphonate, sulfate or sulfonate motif having at least one free acid function,
- n has a value between 0 and 95,
- p has a value between 95 and 5,
- 10 - q has a value between 0 and 95,
- the sum of n + p + q is equal to 100,
- R₁ and R₂ can simultaneously be hydrogen, or while one is hydrogen, the other can be a carboxylic function esterified or not by an alcohol in C₁ to C₁₂,
- 15 - R₃ can be hydrogen or an alkyl radical in C₁ to C₁₂,
- R₄ and R₅ are, simultaneously or not, hydrogen or an alkyl radical in C₁ to C₁₂, a substituted or unsubstituted aryl, a carboxylic function esterified or not by an alcohol in C₁ to C₁₂,
- 20 - R₆ is a radical that establishes the bond between the motif Z and the polymer chain, which radical R₆ can be an alkylene of formula (CH₂)_r in which r can have the values in the interval 1 to 12, an alkylene oxide or polyoxide of formula (R₈—O)_s in which R₈ is an alkylene in
- 25 C₁ to C₄ and s can have a value from 1 to 30, or a combination of the two formulas (CH₂)_r and (R₈—O)_s,
- R₇ is hydrogen or an alkyl radical in C₁ to C₁₂,

- R_9 and R_{10} are simultaneously hydrogen, or while one is hydrogen, the other is a carboxylic grouping, an ester in C_1 to C_{12} , , an alkyl in C_1 to C_{12} , or an alkylaryl,

- R_{11} is hydrogen, a carboxylic grouping, an alkyl in
5 C_1 to C_3 or a halogen,

- R_{12} is an ester in C_1 to C_{12} , a substituted or unsubstituted amide, an alkyl in C_1 to C_{12} , an aryl in C_5 or C_6 , an alkylaryl, a halogen, a carboxylic grouping or a phosphatized, phosphorylated, sulfated or sulfonated alkyl
10 or aryl grouping.

14. Method according to claim 13, characterised in that the motif Z, the non-free acid functions are occupied by a cation, an ammonium grouping, an amine, an alkyl in C_1 to
15 C_3 , a substituted or an unsubstituted aryl in C_3 to C_6 , an alkylaryl, an ester in C_1 to C_{12} , preferably in C_1 to C_3 , or a substituted amide.

15. Method according to claim 13, characterised in that in
20 the sum of $n + p + q$, $n = 0$, when $q > 0$, and $q = 0$ when $n > 0$.

16. Method according to claim 13, characterised in that, in the motifs R_1 and R_2 , the alcohol esterifying the
25 carboxylic function is preferably in C_1 to C_4 .

17. Method according to claim 13, characterised in that, in the motif R_3 , the alkyl radical is preferably in C_1 to
30 C_4 .

18. Method according to claim 13, characterised in that, in the motifs R_4 and R_5 , the alkyl radical is preferably in C_1 to C_4 .

19. Method according to claim 13, characterised in that, in the motifs R_4 and R_5 , the alcohol esterifying the carboxylic function is preferably in C_1 to C_4 .

5 20. Method according to claim 13, characterised in that, in the motif R_7 , the alkyl radical is preferably in C_1 to C_4 .

21. Method according to claim 13, characterised in that,
10 in the motifs R_9 and R_{10} , the ester is preferably in C_1 to C_3 .

22. Method according to claim 13, characterised in that,
in the motifs R_9 and R_{10} , the alkyl is preferably in C_1 to
15 C_3 .

23. Method according to claim 13, characterised in that, in the motif R_{12} , the ester is preferably in C_1 to C_5 .

20 24. Method according to claim 13, characterised in that, in the motif R_{12} , the alkyl is preferably in C_1 to C_3 .

25. Method according to claim 13, characterised in that the molecular weight of the water-soluble acrylic
25 copolymers forming the stabilisation agent is between 5000 and 100,000.

26. Method according to claim 13, characterised in that the water-soluble acrylic copolymers forming the
30 stabilisation agent are at least partially neutralised, by means of a neutralisation agent chosen from the group consisting of sodium, potassium, ammonium, calcium and magnesium hydroxides, and primary, secondary and tertiary amines, aliphatic and/or cyclic, in particular mono-, di-

and tri-ethanolamines, mono- and diethylamines, cyclohexylamine and methylcyclohexylamine.

27. Method according to any one of claims 10 to 13,
5 characterised in that the weight of the water-soluble stabilisation agent, expressed as a dry/dry weight percent of said agent with respect to the weight of the powder particles in suspension, is between 0.02 % and 5 %, and preferably between 0.1 % and 2 %.

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28. Method according to at least one of claims 1 to 27, characterised in that said method is performed in at least one hydraulic separator equipped with at least one dynamic stabilisation means.

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29. Method according to claim 28, characterised in that, when said method is performed in a single hydraulic separator, the chosen density "ds" changes:

- in the increasing direction, by a controlled
20 addition of predefined and selected powder particles to the suspension present in the hydraulic separator, until the new chosen threshold density "ds" is reached,

- in the decreasing direction, by adding water until the new chosen threshold density "ds" is reached.

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30. Method according to claim 29, characterised in that the change in density of the stable separating suspension, in an increasing or decreasing direction, is carried out under agitation by means of an agitation rotor and/or
30 internal recirculation of the aqueous medium and/or recirculation of the dense medium by withdrawing the dense aqueous medium from the base of the hydraulic separator and reinjecting it into the top portion of said separator of the dense aqueous medium being adjusted.

31. Method according to claim 28, characterised in that, if said method is performed in a plurality of hydraulic separators, the various separators are placed one after another, in a cascade system functioning with stable
5 suspensions each having a specific density threshold "ds", in an increasing or decreasing order of density.

32. Method according to any one of claims 28 to 31, characterised in that the threshold density "ds" of the
10 aqueous suspension for fine separation is continuously controlled by appropriate measurement means and subjected to an adjustment when any deviation is detected.

33. Method according to claim 32, characterised in that
15 each hydraulic separator is controlled with regard to the density of the dense medium that it contains by means of two electrical valves each opening onto two circuits connected to two tanks, one of the tanks containing a "mother" suspension with a concentration of around 60 %
20 powder particles, stabilised by a water-soluble stabilizing agent, enabling a predetermined amount of the mother suspension to be added, which adjusts upward any deviation toward a reduction in the density of the dense medium for fine separation, and the other tank containing
25 water enabling a predetermined amount to be added so as to adjust downward any deviation toward an increase in the density of the dense medium for fine separation.

34. Method according to claim 33, characterised in that,
30 in each hydraulic separator, the measurement of the density of the dense medium is performed continuously by suitable measuring apparatuses that activate the opening of one or the other of the electrical valves, then the

closing thereof when the threshold density level "ds" is reached.

35. Use of the method according to at least one of claims
5 1 to 34 for the selective separation of a mixture of
polymer materials, in particular used, from the
destruction of automobiles and/or durable consumer goods
that have reached the end of their serviceable lives.